Space Weather Technical Forecast

Issued on Wednesday, 29 December 2021 at 12:34 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: Slight chance of G1/Minor Geomagnetic storms. Chance of R1 radio blackouts. Chance of Active fluence.

Analysis of Space Weather Activity over past 24 hours
Solar Activity: Solar activity has reached Moderate levels over the past 24 hours, with one M-class flare from AR2918. There are currently five active regions on the visible disc. 2918 in the northwest produced the recent M-class flare, and shows signs of developing a mixed polarity spot. 2916 in the southwest remains the largest region, with recently developed 2921 in the northwest also rather large, but neither has produced any noteworthy flares. The other regions are weak and stable.
No Earth-directed Coronal Mass Ejections (CMEs) were observed in available imagery during the period.

Solar Wind / Geomagnetic Activity: The solar wind speed as observed by DSCOVR at L1, was elevated at first around 530 km/s, easing to ambient levels currently near 360 km/s. The density was above average to start, becoming average from 28/1600 UTC. The IMF started at moderate levels around 8nT but soon became weak. The north-south component Bz varied between +/-5 nT. Finally, the phi angle was mostly positive (away from the sun). Geomagnetic activity was Quiet (Kp 0-2). These parameters suggest a waning connection to CH38/+ or CH39/+.

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV) remained at Background levels. The high energy electron flux (greater than 2 MeV) was at background to moderate levels. The fluence dropped sharply to start the period, then levelled off from 28/1800 UTC. Observed fluence at 29/0000UTC was 5.97e6 integrated pfu.

Four-Day Space Weather Forecast Summary
Solar Activity: Low to Moderate solar activity is forecast to continue throughout the period with a chance of further isolated M-class flares, most likely from AR2916 and AR2918. No significant regions are anticipated to rotate onto the visible disc from the far-side during the period.

Solar Wind / Geomagnetic Activity: Earth may experience a glancing blow from a CME on Day 2 (30 Dec), but this is low confidence. Wind speeds are currently ambient, but may reach slightly elevated levels at times until Day 4 (01 Jan) when a fast wind from CH40/+ is likely to arrive. Geomagnetic activity is forecast to be largely Quiet to Unsettled. There is a chance of Active intervals through the period and a slight chance of a G1/Minor Geomagnetic storm, this most likely on Day 4.

Energetic Particles / Solar Radiation: The high energy (greater than 10 MeV) proton flux is expected to remain at background levels, albeit with a very slight chance of S1 should there be any significant flare activity. High energy electron flux (greater than 2MeV) levels may rebound to reach high levels at the daily maxima through to Day 3 (31 Dec), before the HSS on Day 4 (01 Jan) may cause a suppression in levels. Fluence levels may rise through Days 1 to 3, with a chance of reaching the Active threshold, before likely falling on Day 4.

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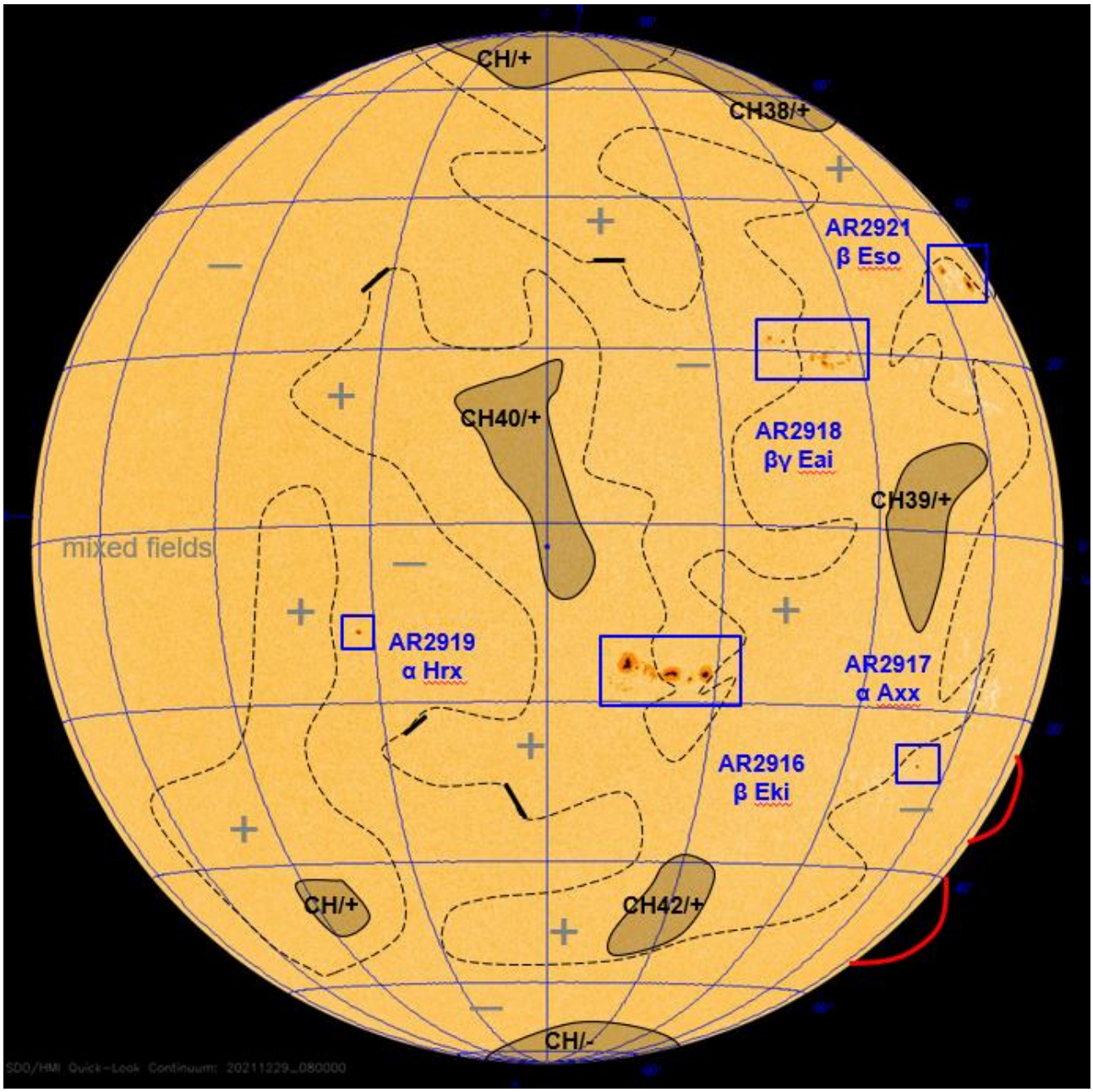
Figure 1. Solar Analysis Valid 29/0800 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

On Day 2 (30 Dec), there is a small chance of peripheral effects from a glancing blow from a filament eruption which occurred 26/2012 UTC. This is currently forecast to most likely miss Earth, but confidence is low given some MOSWOC Enlil ensemble members have glancing blows at Earth. No other CMEs feature in the current forecast.

The coronal hole forecast for the period is of low confidence due to differences from the previous rotation. STEREO-A data does suggest a slight enhancement in solar wind speeds through Days 1 and 2 (29 and 30 Dec), but the data is very noisy and difficult to interpret. Wind speeds are currently ambient after easing from either CH38 or 39. It seems likely that wind speeds will remain ambient, or perhaps slightly elevated, until Day 4 (01 Jan), when there appears to be a more assured high speed stream from a persistent coronal hole, CH40/+. Wind speeds are likely to reach 500 km/s from this feature.

Geomagnetic activity is forecast to be largely Quiet to Unsettled. There is a chance of Active intervals through the period and a slight chance of a G1/Minor Geomagnetic storm, this most likely on Day 4.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	5	10	5	20
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
27/0418	N/A	Filament eruption	SW quadrant	500 km/s	Probable miss. Minority Enlil ensemble members suggest later on Thursday 30 Dec UTC day.	Possible glancing blow

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Figure 2: AIA-193 imagery showing this rotation (left) and previous rotation (right) with several differences between them.

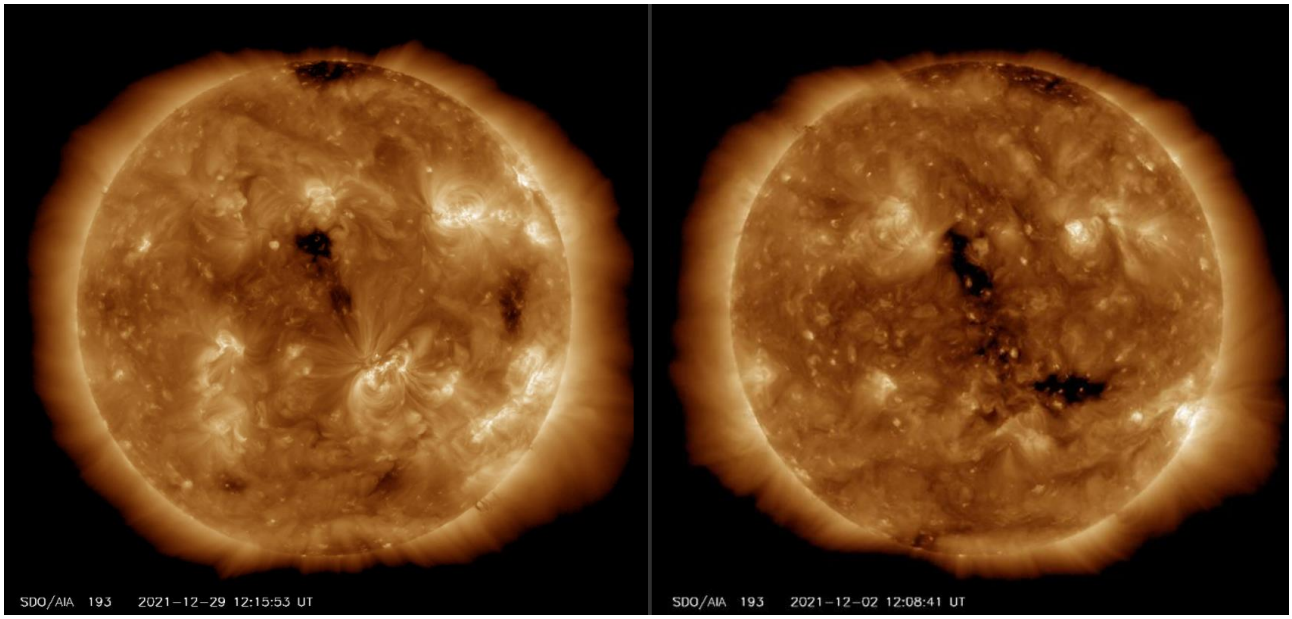
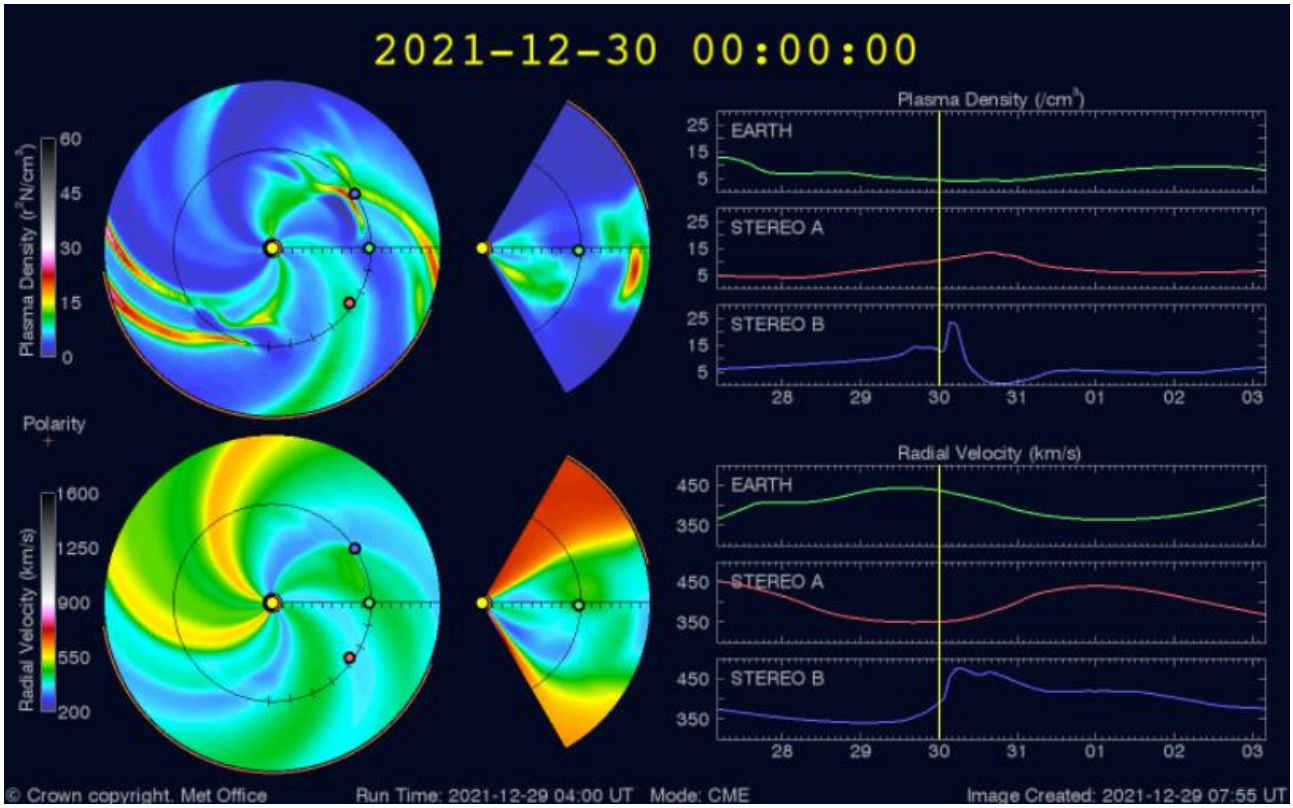


Figure 3: Enlil run showing CME likely missing ahead of Earth's orbit on 30 December.



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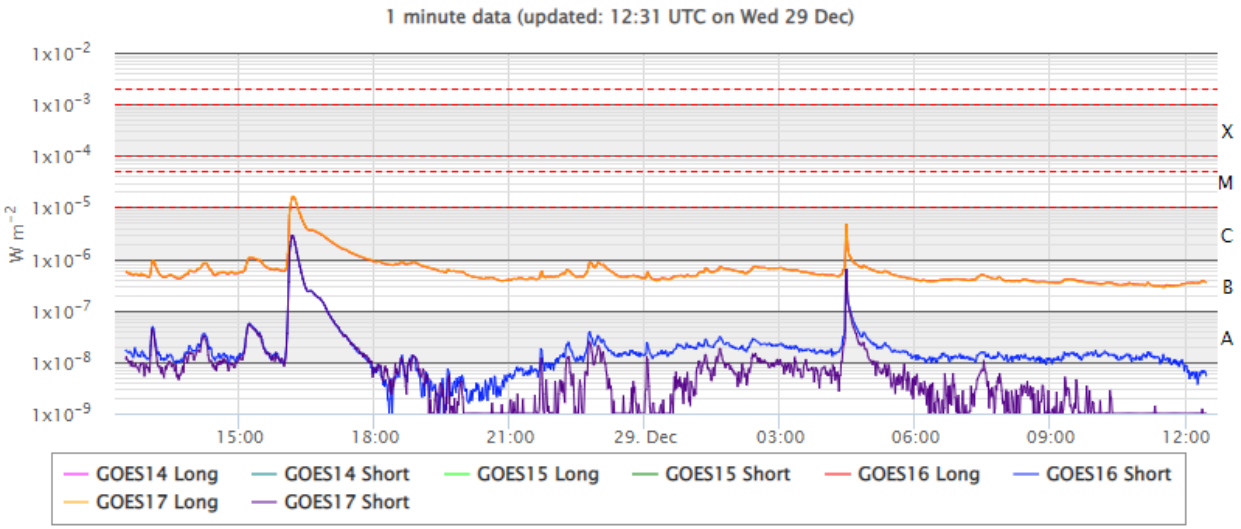
Radio Blackouts - X-Ray Flares:

Solar Activity has been Low to Moderate, with one M-class flare and one larger C-class flare observed in the last 24 hours. Background X-ray flux recorded at GOES-16 continued to show an overall decline. The largest region on the disc, AR2916 (Eki/Beta), is relatively stable and magnetically fairly simple. It did however give the recent C-class flare. AR2918 is slightly more magnetically complex and was responsible for the recent M-class flare. AR2921 in the far northwest is quite a large region but also appears to be magnetically simple and hasn't yet given any notable flares. The other regions are small and simple.

In terms of overall trends, no major returning regions are forecast over the eastern limb in the coming four-day period, but AR2921 will rotate off. This should give a slight decline in background x-ray levels. Solar activity is expected to be Low, with further C-class flares. There is a daily chance of activity increasing to Moderate levels, with further isolated M-class flares. These are most likely to come from active regions 2916 and 2918.

X Ray Flares Probability	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	R1-R2 M Class	Yes	40	40	40	40
Very Active	R3 to R5 X Class	No	5	5	5	5

Figure 4: X-ray flare trace showing recent flares



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Solar Radiation Storms - (High Energy Protons):
The high energy proton flux (greater than 10 MeV) as observed by GOES-16 is currently at background levels and will most likely persist as such. There is a very slight chance of S1 from any notable flares on the disc, perhaps most likely from AR2916 or AR2918 as they rotate across the western hemisphere.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	5	5	5	5
Very Active	**≥ S3 ***	No	1	1	1	1

* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)

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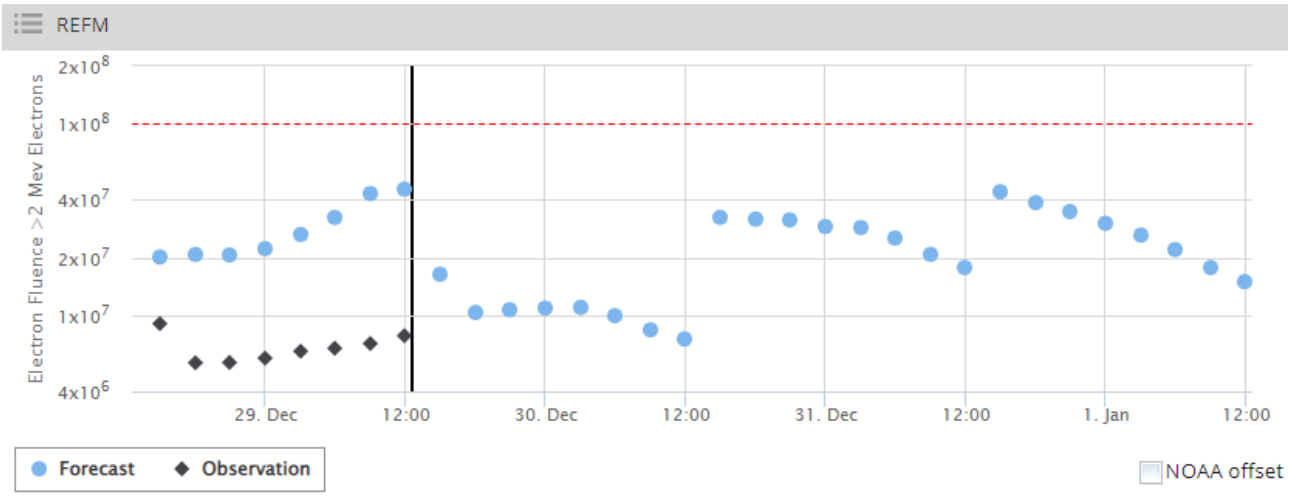
High Energy Electrons Event (≥ 2MeV):
Electron flux levels have dropped to background or moderate levels since the high speed stream (HSS) arrival from CH38 or 39. This is likely to be due to compression of the radiation belts from the HSS. Wind speeds have now returned to ambient levels, with another HSS likely on Day 4 (01 Jan). As the radiation belts de-compress, it is possible that flux levels will bounce back to reach high levels at the diurnal maxima on Days 2 and 3 (30 and 31 Dec), before another suppression is likely with the next HSS on Day 4.

As such, fluence levels may start to rise again on Days 2 and 3, with a chance of reaching Active levels during this time. REFM is suggesting a rise in fluence, although keeping levels below the Active threshold. This seems to be a good general trend, although there is low confidence in the peak fluence levels expected. The likely flux suppression on Day 4 should then cause a decrease in fluence levels at this time.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	5	30	30	10
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

Figure 5: REFM model showing increasing fluence trend but below Active threshold. Low confidence in peak fluence values, with a chance of reaching Active levels Days 2 and 3 (30 and 31 Dec).



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